

Virtual Hospital

Velibor Božić

General hospital Koprivnica, Koprivnica, Croatia

e-pošta: veliborbozic@gmail.com

Abstract: Smart hospital is a relatively familiar concept, and it has become a reality. In this paper, we go a step further and problematize the virtual hospital. The aim of the paper is to show that the virtual hospital is achievable and has its own purpose. The hypothesis is that the virtual hospital helps to improve healthcare. The methods used in the investigation are the study of literature, analysis of the same, as well as analysis of concepts like avatar, Internet of Things (IoT), Big Data and Digital Twins. The expected results of this research will show that creating a virtual hospital is possible and that it helps in providing better healthcare.

Keywords: Artificial Intelligence; Big Data; Digital Twins; IoT; Virtual hospital

Introduction

Do you know the movies Matrix or Avatar? These are science fiction films that talk about virtual reality in which avatars of real people live in virtual reality driven by the thoughts of real people. The assumption from the mentioned films, thanks to the development of technology, is becoming closer to reality. Virtual reality and its avatars in the service of improving healthcare is the topic of this paper. The aim of this paper is to show that the existence of a virtual hospital makes sense. The goal of the work is to show that the virtual hospital is achievable and has its own purpose. The hypothesis to be tested is that the virtual hospital helps to improve health care. The methods used in testing the hypothesis are the study of literature, analysis of the same, analysis of concepts such as avatar, Internet of Things (IoT), Big Data and Digital Twins. The expected results of the research are to show that creating a virtual hospital is possible and that it helps in providing better healthcare. First, the basic terms are explained. This is followed by discussion about creating your own avatar with assistance of modern technologies and how it can help in the field of healthcare. Furthermore, it explains how one can manage one's own avatar in virtual reality. It is emphasized that own avatars do help in health care. The paper discusses the risks associated with avatars and virtual reality, how to reduce these risks and how to manage conflicts between avatars. Furthermore, it is discussed whether it is possible to create a virtual hospital with avatars as patients and how this virtual hospital can help the "real" hospital. The difference between a smart and a virtual hospital is discussed and what are the prerequisites for creating a virtual hospital. Finally, certain conclusions are drawn.

What is avatar?

It can refer to several different things, but generally avatar is used to describe a digital representation of a person in a virtual world or online forum.

Avatars (1), (2) in healthcare refers to the use of virtual representations of individuals, known as avatars, in the field of healthcare. Avatars can be used in a variety of ways in healthcare, such as in telemedicine consultations, virtual reality therapy, and medical education. They can also

be used to simulate surgeries or other procedures, allowing doctors and other healthcare professionals to practice and improve their skills. Avatars can also be used to create personalized treatment plans for patients, based on their individual characteristics and medical history.

Are we closer to create Avatar with combination of IoT, Big Data and Digital Twin?

The combination of Internet of Things (IoT), Big Data, and Digital Twin technology is bringing us closer to creating avatars that are more realistic and interactive.

IoT (3) devices can be used to gather data on a person's physical characteristics, movements, and behaviour, which can then be used to create a more accurate digital representation of that person.

Big Data (4) can be used to analyze and process this information in real-time, allowing the avatar to respond and interact in a more natural way.

Digital Twin (5) technology can be used to create a virtual replica of a person, machine, or product, which can be used for simulation, testing, and analysis. Together, these technologies are helping to create avatars that are more realistic and interactive, making them useful for a wide range of applications, such as virtual reality, gaming, and remote communication.

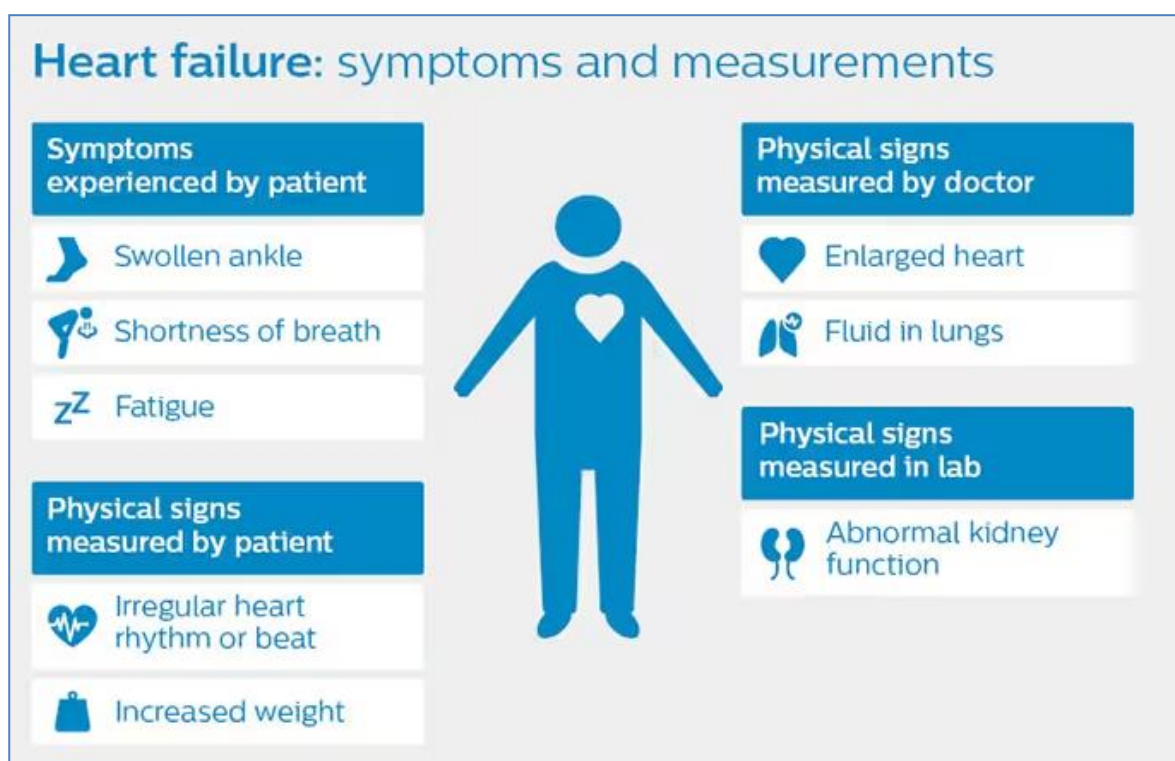


Figure 1. Self-avatar (digital patient)

Source: *The digital patient: will we one day have our own health avatars?* (citeate: 25-Jan-2023).

Available: <https://www.philips.com/a-w/about/news/archive/blogs/innovation-matters/20181211-the-digital-patient-will-we-one-day-have-our-own-health-avatars.html>

Is it possible to create "self-avatar" and use it in healthcare?

It is possible to create "self-avatars" and use them in healthcare. Self-avatars are digital representations of an individual that are created and controlled by the individual themselves. They can be created using the same technologies I mentioned earlier, such as IoT, Big Data, and Digital Twin.

In healthcare, self-avatars (2) can be used in a variety of ways. For example, they can be used to create virtual patient simulations for training medical professionals. They can also be used to help patients communicate with healthcare providers remotely, such as through virtual consultations. Additionally, self-avatars can be used to monitor a patient's health and provide real-time feedback to both the patient and the healthcare provider. Self-avatar can also be used in telemedicine and telehealth, allowing a patient to interact with a doctor or therapist in a virtual environment, and in mental health and psychological support.

It is important to note that creating and using self-avatars in healthcare raises several ethical and legal concerns, such as data privacy and security. It is also important to ensure that the technology is accessible to all people, regardless of their physical abilities or socioeconomic status.

Metaverse

A metaverse (6) is a virtual world, or a collection of virtual worlds, that can be accessed by users through the internet. It is often used to describe a collective virtual shared space, created by the convergence of virtually enhanced physical reality and physically persistent virtual reality, in which people can interact in both real and virtual forms. The concept of a metaverse has been popularized in science fiction and is often used in the context of virtual reality gaming and other immersive experiences.

Can we manage with self-avatars in metaverse?

Self-avatars (7) can be used to manage and navigate the metaverse. The metaverse refers to a virtual shared space where users can interact and engage with each other in a variety of ways. It is a concept that is gaining traction as technology advances and more people spend time in virtual environments.

Self-avatars can be used in the metaverse as a way for users to represent themselves and interact with others. These avatars can be customized to reflect the user's physical appearance, personality, and preferences. They can also be used to perform a variety of actions, such as exploring virtual environments, communicating with other users, and participating in various activities.

Self-avatars in the metaverse can be controlled by the user through various inputs, such as voice commands, hand gestures, or brain-computer interfaces. The use of IoT devices, such as sensors and wearables, can also be used to gather data on the user's physical characteristics, movements, and behavior, which can then be used to create a more accurate digital representation of that person.

It is important to note that the development of the metaverse is still in its early stages, and there are many challenges that need to be addressed in terms of security, privacy, and the accessibility of the technology.

How metaverse and self-avatars can be used in healthcare?

The metaverse and self-avatars can be used in healthcare in several ways. Here are a few examples (8), (9), (10):

- **Virtual consultations:** Patients can use self-avatars to interact with healthcare providers in a virtual environment, allowing for remote consultations and reducing the need for in-person visits.
- **Training and education:** Medical professionals can use self-avatars to participate in virtual training and education programs, allowing them to practice procedures and skills in a simulated environment.
- **Mental health and psychological support:** Patients can use self-avatars to participate in virtual therapy sessions with a therapist or counsellor, allowing them to receive support in a comfortable and private environment.
- **Rehabilitation and physical therapy:** Patients can use self-avatars to participate in virtual rehabilitation and physical therapy programs, allowing them to perform exercises and movements in a safe and controlled environment.
- **Clinical trials and research:** Researchers can use self-avatars to simulate patient scenarios in virtual environment, allowing them to test new treatments and therapies in a controlled environment before they are applied in real life.

It is important to note that the use of metaverse and self-avatars in healthcare must be guided by robust security, privacy, and ethical considerations. It is also important to keep in mind that virtual experiences may not be suitable for all patients, and it is important to ensure that the technology is accessible to all people, regardless of their physical abilities or socioeconomic status.

Risks

There are several risks associated with the use of metaverse (11) and self-avatars in various areas, including healthcare. Here are a few examples:

- **Security and Privacy:** The use of metaverse and self-avatars raises concerns about data privacy and security. Personal information and medical data must be protected from unauthorized access and breaches.
- **Cyberbullying and Harassment:** Virtual environments can provide anonymity, which may lead to increased instances of cyberbullying and harassment.
- **Addiction:** Spending too much time in virtual environments can lead to addiction, which can have negative effects on a person's physical and mental health.
- **Social Isolation:** Spending too much time in virtual environments can lead to social isolation, which can have negative effects on a person's mental health.
- **Accessibility:** Not everyone has access to the technology required to participate in virtual environments, and that can lead to a digital divide and social exclusion.
- **Ethical concerns:** Self-avatars can be used to simulate patient scenarios in virtual environment, but using real patient data can raise ethical concerns, such as informed consent, autonomy, and data protection.

It is important to consider these risks and take steps to mitigate them when developing and implementing metaverse and self-avatar technology in various areas, including healthcare.

Additionally, regulations and guidelines must be established and followed to ensure that technology use is safe and ethical.

In which way, we can mitigate these risks?

There are several ways to mitigate the risks associated with the use of metaverse (12) and self-avatars in various areas, including healthcare. Here are a few examples:

- **Security and Privacy:** Implementing robust security measures, such as encryption and authentication, can help protect personal information and medical data from unauthorized access and breaches. It is also important to have clear and transparent policies in place for data collection, storage, and sharing.
- **Cyberbullying and Harassment:** Implementing policies and procedures for reporting and addressing cyberbullying and harassment, as well as providing education and resources for users on how to recognize and respond to these behaviors.
- **Addiction:** Implementing usage limits and providing resources for users to monitor and manage their time spent in virtual environments can help prevent addiction.
- **Social Isolation:** Encouraging users to maintain connections with the real world and providing opportunities for social interaction within virtual environments can help mitigate social isolation.
- **Accessibility:** Ensuring that the technology is accessible to all people, regardless of their physical abilities or socioeconomic status, can help prevent digital divide and social exclusion.
- **Ethical concerns:** Establishing regulations and guidelines that ensure informed consent, autonomy and data protection can help mitigate ethical concerns. It is also important to ensure that virtual patient scenarios are not too similar to real patients and that the data used is de-identified.

It's important to keep in mind that risk mitigation is an ongoing process that requires regular review, evaluation, and adjustments as new risks and concerns arise. It is essential to have a team of experts, including legal, security and privacy experts, to help guide the development, deployment, and usage of metaverse and self-avatar technology to mitigate any risks that may arise.

How can we handle with conflicts among avatars in metaverse?

Managing conflicts (11), (12) among avatars in the metaverse can be a complex task, as it involves handling a wide range of issues, such as harassment, bullying, and intellectual property rights. Here are a few strategies that can be used to handle conflicts among avatars in the metaverse:

- **Developing clear policies and guidelines:** Having clear and detailed policies and guidelines in place that outline acceptable behavior, as well as procedures for reporting and addressing violations, can help to prevent conflicts from arising in the first place.
- **Providing education and resources:** Providing education and resources for users on how to recognize and respond to conflicts can help to empower them to take action when necessary.

- Establishing a system for reporting and resolving conflicts: Setting up a system for users to report conflicts and for a designated team to investigate and resolve them can help to ensure that conflicts are handled in a timely and effective manner.
- Enforcing consequences: Enforcing consequences, such as suspension or termination of accounts, for users who violate policies and guidelines can help to deter future conflicts.
- Encouraging communication and collaboration: Encouraging communication and collaboration among users can help to build a sense of community and foster a culture of mutual respect.
- Building in-metaverse mediation mechanisms: Building in-metaverse mediation mechanisms, such as virtual arbitrators or virtual courts, can help to resolve disputes in a more efficient way.

It's important to keep in mind that conflict management is an ongoing process that requires regular review, evaluation, and adjustments as new conflicts and concerns arise. It is also important to ensure that the approach is fair, impartial, and respectful of human rights.

Virtual hospitals with avatars as patients

The concept of virtual hospitals using avatars as patients is a realistic possibility as technology advances and more people spend time in virtual environments. Virtual hospitals can provide a wide range of benefits (13), such as:

- Remote access to healthcare: Virtual hospitals can allow patients to access healthcare services remotely, which can be especially beneficial for people living in remote or underserved areas.
- Reduced costs: Virtual hospitals can reduce costs associated with traditional in-person visits, such as travel expenses and lost wages.
- Increased efficiency: Virtual hospitals can increase efficiency by allowing healthcare professionals to see more patients in a shorter amount of time.
- Improved patient outcomes: Virtual hospitals can improve patient outcomes by providing patients with access to a wider range of healthcare services and specialists.
- Training and education: Virtual hospitals can be used to train medical professionals, allowing them to practice procedures and skills in a simulated environment.

However, there are also challenges that need to be addressed in terms of security, privacy, and the accessibility of the technology. It is also important to ensure that virtual hospitals provide equivalent level of care as traditional in-person visits and that the technology is accessible to all people, regardless of their physical abilities or socioeconomic status.

It is important to note that the development of virtual hospitals is still in its early stages, and more research and development is needed to fully realize the potential of this concept.

How can we make "real healthcare" with the help of virtual hospital?

The use of virtual hospitals can help make "real healthcare" more accessible and efficient in a number of ways (14), (15):

- Remote Monitoring: Virtual hospitals can use IoT devices and wearables to monitor patients' health in real-time, allowing healthcare professionals to quickly identify and address any issues that arise.

- **Virtual Consultations:** Virtual hospitals can provide virtual consultations, allowing patients to interact with healthcare professionals remotely, reducing the need for in-person visits.
- **E-Prescriptions and E-Referrals:** Virtual hospitals can use digital tools such as e-prescriptions and e-referrals to streamline the healthcare process, making it more convenient for patients and healthcare professionals.
- **Telemedicine:** Virtual hospitals can use telemedicine to provide patients with remote access to specialists, reducing the need for travel and increasing access to healthcare services.
- **Clinical trials and Research:** Virtual hospitals can allow for remote participation in clinical trials and research, increasing patient participation and providing access to new treatments and therapies.
- **Virtual Rehabilitation and Physical therapy:** Virtual hospitals can use virtual rehabilitation and physical therapy programs, allowing patients to perform exercises and movements in a safe and controlled environment.

It is important to note that virtual hospitals should be integrated with real healthcare systems and should not be seen as a replacement for traditional in-person healthcare services. The virtual hospital should also be integrated with existing EHR and other clinical systems to provide continuity of care and ensure patient data is shared in a secure way.

It's also important to keep in mind that the use of virtual hospitals must be guided by robust security, privacy, and ethical considerations, and that the technology should be accessible to all people, regardless of their physical abilities or socioeconomic status.

The difference between smart and virtual hospital

A "smart hospital" (16), (17) and a "virtual hospital" (18) are related but different concepts.

A smart hospital is a type of hospital that uses advanced technology to improve the quality and efficiency of healthcare services. This can include things like electronic health records (EHRs), telemedicine, remote monitoring, and automation of certain processes. A smart hospital utilizes technology to improve the quality of care and make healthcare more accessible and efficient, but still relies on traditional in-person visits.

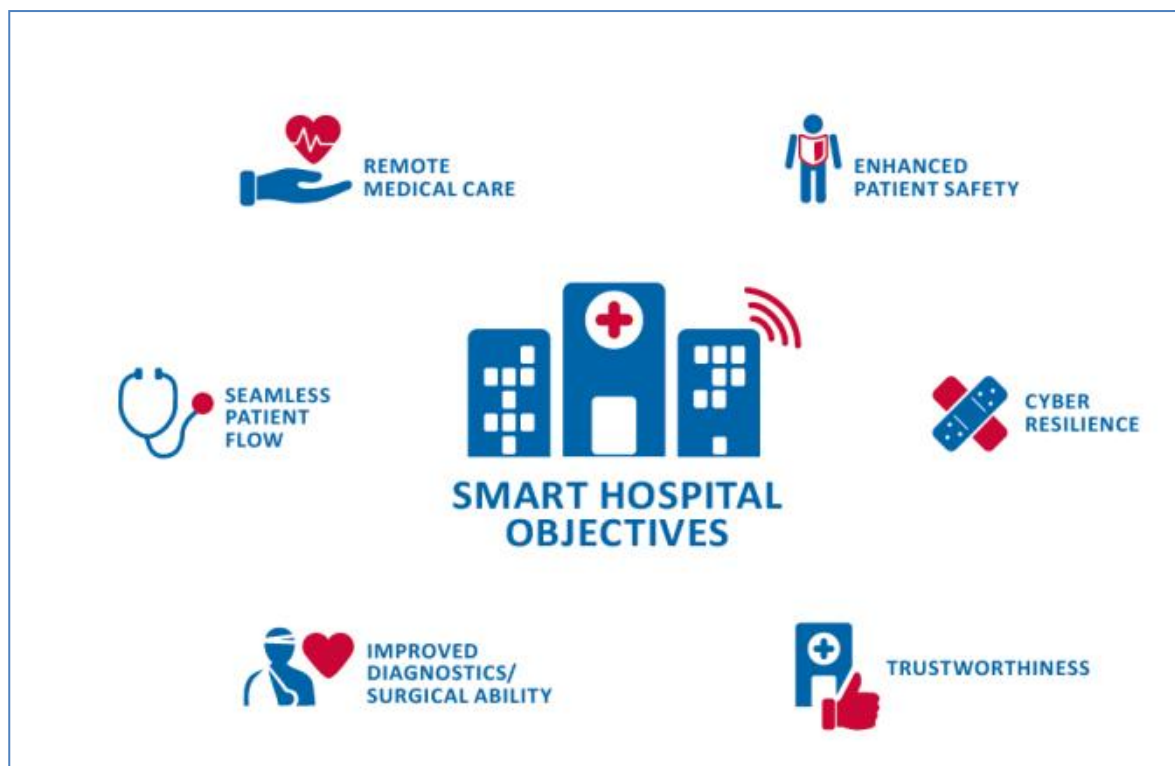


Figure 2. Objectives in smart hospital

Source: *Smart Hospitals Security and Resilience for Smart Health Service and Infrastructures*. “ENISA”. 2016 Nov.

A virtual hospital, on the other hand, is a hospital that exists entirely in a virtual environment. It allows patients to access healthcare services remotely, using digital tools such as virtual consultations, telemedicine, and remote monitoring. Patients interact with healthcare professionals and other patients through avatars, and the hospital can exist in a virtual world. A virtual hospital relies on virtual means of communication and interactions with patients and healthcare professionals, reducing or eliminating the need for traditional in-person visits.



Figure 3. Using AI, IoT, Digital Twins for remote healing

Source: (cite 25. 1. 2023) Available: <https://www.med-technews.com/news/virtual-wards-created-for-remote-monitoring-of-covid-19-pati/>

Both smart and virtual hospitals are utilizing technology to improve healthcare, but they do it in different ways. A smart hospital uses technology to improve and streamline traditional in-person healthcare, while a virtual hospital relies on virtual interactions and aims to provide healthcare services remotely.

Could we predict in which term period, virtual hospital will be possible, and which are preconditions for existing virtual hospital?

It is difficult to predict exactly when virtual hospitals will become a reality, as it will depend on several factors such as technological advancements, investment in research and development, and changes in regulations and policies. However, the concept of virtual hospitals is gaining traction as technology advances and more people spend time in virtual environments.

The key preconditions (19) for existing virtual hospitals include:

- **Adequate technology:** Virtual hospitals rely on advanced technology such as virtual reality, telemedicine, and remote monitoring. These technologies must be developed and refined to a point where they can provide the same level of care as traditional in-person visits.
- **Investment in research and development:** Virtual hospitals require significant investment in research and development to fully realize their potential.
- **Changes in regulations and policies:** Virtual hospitals require changes in regulations and policies to ensure that the technology is used in a safe and ethical manner.
- **Accessibility:** Virtual hospitals must be accessible to all people, regardless of their physical abilities or socioeconomic status.
- **Data privacy and security:** Virtual hospitals must ensure the protection of personal information and medical data from unauthorized access and breaches.
- **Interoperability:** Virtual hospitals should be integrated with existing healthcare systems and should not be seen as a replacement for traditional in-person healthcare services. The virtual hospital should also be integrated with existing EHR and other clinical systems to provide continuity of care and ensure patient data is shared in a secure way.

As technology continues to advance and more people spend time in virtual environments, it is likely that we will see virtual hospitals becoming a reality in the future. The exact time frame for this is uncertain, but it is likely to happen within the next decade or so.

Conclusion

From the present point of view, avatars and virtual hospitals are emerging technologies that have the potential to revolutionize the way the healthcare is delivered. The combination of Internet of Things (IoT), Big Data, and Digital Twin technology is bringing us closer to creating avatars that are more realistic and interactive. IoT devices can be used to gather data on a person's physical characteristics, movements, and behavior, which can then be used to create a more accurate digital representation of that person. Big Data can be used to analyze and process this information in real-time, allowing the avatar to respond and interact in a more natural way.

Virtual hospitals, on the other hand, are a concept that is gaining traction as technology advances and more people spend time in virtual environments. They can provide a wide range of benefits,

such as: Remote access to healthcare, reduced costs, increased efficiency, and improved patient outcomes, training and education.

The hypothesis that the virtual hospital can help improve health care was confirmed by the method of analyzing the literature and presenting the facts about the virtual hospital throughout the work.

However, there are also challenges that need to be addressed in terms of security, privacy, and the accessibility of the technology. It is also important to ensure that virtual hospitals provide equivalent level of care as traditional in-person visits and that the technology is accessible to all people, regardless of their physical abilities or socioeconomic status.

It is important to note that the development of virtual hospitals and avatars is still in its early stages, and more research and development is needed to fully realize the potential of these concepts. It is also important to ensure that their use is guided by robust security, privacy, and ethical considerations.

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Virtualna bolnica

Velibor Božić

Opća bolnica Koprivnica, Koprivnica, Hrvatska

e-mail: veliborbozic@gmail.com

Sažetak: Pametna bolnica je relativno poznat koncept koji danas već postaje stvarnost. U ovom radu idemo korak dalje i problematiziramo virtualnu bolnicu. Cilj rada je pokazati da je virtualna bolnica ostvariva i da ima svoju svrhu. Hipoteza je da virtualna bolnica može pomoći u poboljšanju zdravstvene skrbi. Metode primijenjene u razmatranjima navedene hipoteze su proučavanje literature, analiza iste, te analiza koncepata poput avatara, Internet of Things (IoT), Big Data i Digital Twins. Očekivani rezultati istraživanja pokazuju da je stvaranje virtualne bolnice moguće i da pomaže u pružanju bolje zdravstvene zaštite.

Ključne riječi: Umjetna inteligencija; Big Data; Digital Twins; IoT; Virtualna bolnica